Electrical Connections Between Pulmonary Veins in Humans
Evidence After Radiofrequency Ablation of the Venoatrial Junction

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A 47-year-old man with an uncorrected ostium primum atrial septal defect complained of frequent episodes of paroxysmal atrial fibrillation since 1990. Class IC and III antiarrhythmic drugs failed to control the recurrences, and the patient was referred to our institution for electrophysiological evaluation. During the procedure, the focal origin of the atrial fibrillation episodes from the right superior and left pulmonary veins (PVs) was demonstrated by means of multielectrode mapping. For this reason, after selective PV angiography, PV electrical disconnection attempts were performed by delivering low-energy radiofrequency pulses close to the corresponding venoatrial junctions. To facilitate the recognition of electrical PV disconnection, a double-catheter technique was used with a reference quadripolar catheter placed distally in the mapped PV and a quadripolar, 4-mm tip, steerable catheter positioned immediately within the ostium of the same vein for mapping and ablation. Target areas were considered those exhibiting the shortest vеноatrial conduction time (in sinus rhythm or distal coronary sinus atrial pacing during right or left PV mapping), as measured from the distal couple of electrodes of the mapping catheter. If changes in the activation breakthrough occurred after radiofrequency applications, the mapping catheter was moved to another segment of the PV perimeter showing the shortest vеноatrial conduction time. Electrical disconnection occurred when the PV potentials abruptly disappeared or were dissociated from the atrial potentials during radiofrequency delivery.

Because the right superior PV focus was the most active in triggering atrial fibrillation episodes, it was the first targeted by radiofrequency applications. Thereafter, the left inferior PV was approached, but only a decrease of the PV potential amplitude and a delay in the vеноatrial conduction was obtained. Finally, the left superior PV was disconnected with the last radiofrequency pulse delivered at the floor of the vеноatrial junction (Figure 1). To complete the procedure, the reference catheter was then reinserted in the left inferior PV for further mapping, while the mapping catheter was kept in the superior branch at the ablation site. Surprisingly, dissociated PV potentials were also recorded in the inferior vein, resulting from a vein-to-vein transmission of the spontaneous left superior PV automatic discharges (Figure 2). This finding unequivocally demonstrates, for the first time in humans, the presence of electrical conduction between PVs and may imply that treatment of contiguous vessels might be required when PV electrical disconnection procedures are attempted.

Figure 1. Left superior PV (LSPV) electrical disconnection. From top to bottom, surface ECG lead V1 is displayed together with bipolar intracardiac recordings obtained from the distal (d) and proximal (p) poles of the coronary sinus (CS) and the left superior PV reference (REF) and ablation (ABL) catheters. A. During distal coronary sinus atrial pacing, the left superior PV reference catheter recorded 2 separate, sharp electrograms reflecting the left atrial and PV (*) activations. A single, multicomponent electrogram timed between the atrial and PV activations is recorded by the distal electrodes of the mapping catheter placed at the vеноatrial conduction breakthrough. B. Radiofrequency (RF) current delivery at this site produces PV electrogram disappearance (arrow) preceded by an increase in the left atrial–PV conduction time. The dissociated PV activity reappears in the right part of the panel.

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Figure 2. Electrical conduction between the left PVs. A and B, Left superior (LS) and inferior (LI) PV–selective angiograms in the anteroposterior view. RSPV indicates right superior pulmonary vein catheter; CS, coronary sinus catheter. C, Fluoroscopic position of the left superior and inferior PV catheters after left superior PV electrical disconnection. D, Spontaneous left superior PV discharges (sharp electrograms indicated by arrowheads in the LSPVd recordings), dissociated from the left atrial activation, are directly transmitted (ie, without an interposed left atrial activation) to the left inferior PV (sharp electrograms indicated by *), demonstrating a vein-to-vein electrical conduction. Because the left superior PV catheter crosses the line of conduction block, no PV potentials are recorded from the proximal pair of electrodes. Abbreviations as in Figure 1.
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